Usefulness of Airway Evaluation in Infants Initially Seen With an Apparent Life-Threatening Event

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Objectives: To determine how often the pediatric otolaryngology service is involved in the initial care of infants with an apparent life-threatening event (ALTE), to assess the usefulness of bronchoscopy and laryngoscopy in diagnosing the underlying etiology, and to describe the long-term airway outcomes and whether these patients were seen by the pediatric otolaryngology service over a 5-year follow-up period.

Design: Retrospective observational study.

Setting: Tertiary children’s hospital affiliated with a university hospital.

Patients: Screened were 187,903 patient visits for infants younger than 12 months. A total of 1148 infants with an ALTE were identified, 471 of whom met study inclusion criteria. To identify the study population, these infants were cross-referenced against a database of 5156 patients who underwent airway evaluation by the pediatric otolaryngology service.

Main Outcome Measures: Airway evaluation with or without intervention.

Results: Four hundred seventy-one infants with an ALTE met study inclusion criteria, 9 of whom subsequently underwent airway evaluation via bronchoscopy, laryngoscopy, or both. Three were referred during their initial ALTE admission, and 6 were seen later in childhood. Five of 9 patients had normal findings, 3 patients had laryngomalacia (including 2 with laryngeal edema), and 1 patient had adenotonsillar hypertrophy. Interventions consisted of 2 supraglottoplasties and 1 adenotonsillectomy.

Conclusions: Among well-appearing infants hospitalized with an ALTE, 98.1% (462 of 471) did not undergo subsequent airway evaluation, and only 0.6% (3 of 471) ultimately required pediatric otolaryngologic surgical intervention during 5 years after the event. This study shows that otolaryngologists are not frequently consulted for well-appearing infants with an ALTE and that airway abnormalities are rare.

The objectives of our study were to determine the incidence and usefulness of pediatric otolaryngology airway evaluation among patients with an ALTE who were otherwise stable but were hospitalized for further evaluation and management. We also reviewed the incidence of airway intervention during a 5-year follow-up period after the initial ALTE.

METHODS

STUDY DESIGN

The study occurred at a tertiary children’s hospital affiliated with a university hospital that serves a region of more than 1 million children and is located in an urban area with more than 270,000 children. The hospital is operated by a large, vertically integrated, not-for-profit health care system (Intermountain Healthcare, Salt Lake City, Utah). The hospital serves as the only children’s hospital in the state and is the sole hospital providing pediatric otolaryngology care. The study was approved by the institutional review boards of the University of Utah and Intermountain Healthcare.

Initial identification of the study cohort consisted of all infants younger than 12 months who had been admitted for an ALTE between January 1, 1999, and December 31, 2003. An ALTE was defined as a sudden event consisting of 1 or more of the following events that were concerning to the caregiver: (1) breathing irregularity (including apnea, choking, and gagging), (2) color change (including cyanosis and pallor), (3) altered muscle tone (including hypotonia and hypertonia), (4) abnormal movements (including clonus), or (5) altered mental status (including unresponsiveness).

Patients were excluded from the study if they met at least 1 of the following criteria: (1) if the patient had a known medical history that could explain the ALTE (such as a seizure disorder), (2) if the patient at presentation to the emergency department or admitting hospital had an apparent diagnosis that could explain the ALTE (such as bronchiolitis), or (3) if the patient had unstable vital signs on presentation to the emergency department.

The infants with an ALTE who met study inclusion criteria were then cross-referenced against a database of 5156 patients who underwent airway evaluation at the same institution between January 1, 1999, and December 31, 2008. This database was compiled using a computer-based screen of all 2008 Current Procedural Terminology codes for bronchoscopy and laryngoscopy (codes 31615-31656 and 31505-31579) performed by the pediatric otolaryngology service during that time frame.

Clinical data for the infants with an ALTE and for the patients undergoing airway evaluation were abstracted from hospital electronic and paper medical records and from otolaryngology clinic medical records. Collected data included the procedure performed, findings, ancillary tests, diagnoses, and all follow-up visit information.

Descriptive statistical analyses were performed to determine the incidence of pediatric otolaryngology evaluation among the ALTE cohort. In addition, descriptive statistics for the study cohort were obtained for patients who underwent airway examination during the ALTE hospitalization or during the follow-up period.

STATISTICAL ANALYSIS

Among 187,903 patient visits, we identified 1148 infants with an ALTE, 471 of whom met study inclusion criteria. Over 10 years, 5156 patients had been seen by the pediatric otolaryngology service for an airway evaluation via bronchoscopy, flexible laryngoscopy, or both. This 10-year period included 5 years during which all the ALTEs occurred and an additional 5 years of follow-up. By cross-referencing the 2 cohorts, 9 patients (6 male and 3 female) were identified who had an airway evaluation, constituting 1.9% of 471 patients.

Among 9 patients, the mean age at ALTE presentation was 55 days (range, 0–237 days). Pediatric otolaryngology service consultations took place at a mean age of 22.8 months. The mean time from an ALTE to consultation was 21 months. Airway findings are as follows: 5 patients (56%) had normal findings, 3 patients (33%) had laryngomalacia (including 2 [22%] with laryngeal edema), and 1 patient (11%) had adenotonsillar hypertrophy. The timing of the examination ranged from 1 day to 60 months after the ALTE. Two of 9 patients had follow-up visits (mean follow-up duration, 3.6 years). No deaths nor further ALTEs were recorded in the follow-up period.

Of 9 patients with an ALTE who had an airway evaluation, only 3 were referred to the pediatric otolaryngology service during their initial ALTE admission. The indications for consultation were gasping, stridor, and aspiration (Table 1). One of 3 patients was found to have laryngomalacia, and supraglottoplasty was performed.
formed. The other 2 patients had normal findings on airway examinations.

The remaining 6 patients were referred to the pediatric otolaryngology service later in childhood for airway evaluation (Table 2). Two of the patients were referred for recurrent upper respiratory tract infections, one of whom also had obstructive sleep apnea and underwent adenotonsillectomy 1.4 years after her ALTE. Another patient was evaluated for a lifelong history of stridor and had supraglottoplasty performed for laryngomalacia. One patient was seen for chronic aspiration, and the remaining 2 patients had stridor after prolonged intubation (these patients had been intubated for dilated hypertrophic cardiomyopathy and intractable seizures, respectively).

Analysis of 471 patients in the ALTE cohort revealed that 188 (40%) were diagnosed as having gastrointestinal reflux disease on discharge, including the 3 patients seen by the pediatric otolaryngology service during their admission for ALTE. Two of 471 patients died at 18 months and 5½ years after their initial ALTE admission. Both patients had developed seizure disorders and developmental delay and then experienced chronic respiratory issues and bulbar insufficiency. Neither patient had been seen by the pediatric otolaryngology service.

### Table 2. Otolaryngology Consultation After the Initial Admission for an Apparent Life-Threatening Event (ALTE)

<table>
<thead>
<tr>
<th>Patient No.</th>
<th>Sex/Age, mo</th>
<th>Time From ALTE to Consultation, mo</th>
<th>Reason for Consultation</th>
<th>Procedure</th>
<th>Finding</th>
<th>Intervention</th>
</tr>
</thead>
<tbody>
<tr>
<td>4/M/56</td>
<td></td>
<td>53</td>
<td>Stridor, Recurrent croup and obstructive sleep apnea</td>
<td>ML, bronchoscopy</td>
<td>Laryngomalacia</td>
<td>Supraglottoplasty</td>
</tr>
<tr>
<td>5/F/19</td>
<td></td>
<td>18</td>
<td>Recurrent croup, Obstructive sleep apnea</td>
<td>ML, bronchoscopy</td>
<td>Laryngomalacia</td>
<td>None</td>
</tr>
<tr>
<td>6/F/60</td>
<td></td>
<td>60</td>
<td>Stridor after intubation (hypertrophic cardiomyopathy)</td>
<td>FL</td>
<td>Normal</td>
<td>None</td>
</tr>
<tr>
<td>7/M/7</td>
<td></td>
<td>6</td>
<td>Chronic aspiration</td>
<td>ML, bronchoscopy</td>
<td>Normal</td>
<td>None</td>
</tr>
<tr>
<td>8/M/45</td>
<td></td>
<td>44</td>
<td>Stridor after intubation (seizure disorder)</td>
<td>FL</td>
<td>Laryngomalacia</td>
<td>None</td>
</tr>
<tr>
<td>9/F/7</td>
<td></td>
<td>5</td>
<td>Recurrent croup</td>
<td>FL</td>
<td>Normal</td>
<td>None</td>
</tr>
</tbody>
</table>

Abbreviations: FL, flexible laryngoscopy; ML, microlaryngoscopy.

There is scant evidence in the otolaryngology literature to clarify the topic. In 1997, McMurray and Holinger published a retrospective medical record review of 30 children who had an ALTE. All were referred to the pediatric otolaryngology service for an airway evaluation after their ALTE. The authors found that 50% of the patients had upper airway anomalies on examination (40% laryngeal and 10% pharyngeal) and that one-third required surgical intervention. Their conclusion was that infants initially seen with an ALTE should undergo endoscopy for an upper airway evaluation.

Our study adds to the body of literature by looking at the broader study population of all infants hospitalized for an ALTE, not just those patients who were referred for pediatric otolaryngology consultation. We found that only 3 patients (0.6%) in our study population were referred to our service during their ALTE admission, and only 1 patient (0.2%) required surgical intervention. Furthermore, during 5 years following the initial ALTE, only 6 of 471 patients (1.3%) were subsequently seen by our service for airway evaluation. Two of these patients (0.4%) required surgical intervention, illustrating that most of these patients did well, despite not having a pediatric otolaryngology consultation. We assume that patients with any significant disease would ultimately come to our institution, as it is the only provider of pediatric subspecialty care in the Intermountain West.

In one aspect, our data are similar to those in the study by McMurray and Holinger; of 9 patients seen by our service, 4 (44%) had upper airway anomalies. However, when looking at the referral source (a well-described large inpatient cohort), this number comprised only a small fraction of the patients with an ALTE. Among 468 patients who did not have an airway evaluation during their ALTE admission, 462 (98.7%) did not require one over the next 5 years. This finding indicates that pediatric otolaryngology consultation is infrequently requested at our institution for well-appearing patients with an ALTE and that ultimately these patients are rarely seen by the pediatric otolaryngology service in the years following their initial ALTE presentation.

Strengths of our study include the large cohort size and the ability to track long-term follow-up and out-
comes data in a large vertically integrated health care system. Most pediatric patients in Utah and southern Idaho are cared for by the same health care system, which is composed of 21 hospitals that all use the same electronic medical record system to log admissions, emergency department visits, pediatric clinic visits, radiology results, and other data. This system underscores the likelihood that, barring relocation, patients with recurrent airway issues would have been identified in this medical record review. Furthermore, our facility is the only provider of pediatric otolaryngology services in the Intermountain West, and patients seen outside of the health care system would likely have been referred back to us for evaluation if recurrent airway issues arose.

There are several limitations to this study, the first being that it is a retrospective analysis. In addition, because ALTE is not a codable diagnosis, the initial patient population was identified using keywords and alternate diagnoses (ie, apnea or hypotonia), and it is possible that some cases were not captured. Furthermore, some of the study population may have moved out of the area during the follow-up period and received treatment at another institution. Finally, our analysis considered only those infants who appeared well on presentation to the emergency department. Patients with an ALTE who are initially seen with airway distress or stridor should undergo otolaryngologic evaluation.

CONCLUSIONS

Our study describes the likelihood that an infant will require a pediatric otolaryngologic airway evaluation within 5 years after a hospital admission for an ALTE. Only patients who were stable on presentation and had no comorbid diagnoses explaining the episode were considered for inclusion in the study cohort. Of 471 patients with an ALTE identified, 1.9% (9 of 471) had a formal airway evaluation, and only 0.6% (3 of 471) ultimately required pediatric otolaryngologic surgical intervention. Our study population differs from cohorts previously reported in that we considered all ALTE presentations at our institution and determined both short-term and long-term necessity for pediatric otolaryngologic referral and intervention. Despite the low rate of initial airway evaluation, we found no evidence of detrimental outcomes caused by a delay in referral during the ensuing 5 years. The results of this study suggest that pediatric otolaryngology evaluation is of low yield in well-appearing infants hospitalized for an ALTE.

Submitted for Publication: June 24, 2010; final revision received November 28, 2010; accepted December 29, 2010.

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Author Contributions: Drs Willis and Grimmer had full access to all the data in the study and take responsibility for the integrity of the data and the accuracy of the data analysis.

Study concept and design: Bonkowski, Srivastava, and Grimmer. Acquisition of data: Willis, Bonkowski, and Grimmer. Analysis and interpretation of data: Willis and Grimmer. Drafting of the manuscript: Willis and Grimmer. Critical revision of the manuscript for important intellectual content: Bonkowski, Srivastava, and Grimmer. Statistical analysis: Willis. Administrative, technical, and material support: Willis, Bonkowski, and Grimmer. Study supervision: Bonkowski and Grimmer.

Financial Disclosure: None reported.

Previous Presentation: This study was presented at the Annual Meeting of the American Society of Pediatric Otolaryngology; April 30, 2010; Las Vegas, Nevada.

REFERENCES